ADVISORY CIRCULAR

DEPARTMENT OF TRANSPORTATION
Federal Aviation Administration
Washington, D.C.

FAR GUIDANCE MATERIAL

Subject: RECOMMENDED PRACTICES AND PROCEDURES FOR THE USE OF ELECTRONIC LONG-RANGE NAVIGATION EQUIPMENT

1. PURPOSE. This advisory circular presents recommended operational practices and procedures for the use of electronic long-range navigation equipment in oceanic or remote land areas.

2. RELATED FAR SECTIONS. FAR 91.1(b), 91.20, 91.75, 91.123, Appendix C of 91, 121.103, 121.355, 121.389, Appendix G of 121, 123.27, and 135.2.

3. RELATED READING MATERIAL. Appendix 1 contains a list of related publications and information on how they may be obtained.

4. BACKGROUND.

a. Recently, many domestic operators have received Civil Aeronautics Board (CAB) Economic Authority to operate over international routes. Additionally, the standards for navigation have been upgraded in a large portion of the airspace over the North Atlantic to accommodate the increasing air traffic. Similar standards are under consideration for some airspace over the Pacific. New navigation equipment is presently being introduced into the aviation community to meet these requirements and to serve as a replacement for Loran A which is scheduled for a phased shutdown through 1980. These factors, as well as others, indicate that effective navigation practices and procedures must be applied by all operators to ensure that a high level of safety is maintained. The recommended operational practices and procedures presented in this advisory circular have proven to be an effective means of attaining successful navigation.

Initiated by: AFO-260

(i.e., INS, Omega), a waypoint is usually inserted as latitude and longitude coordinates. For semi-automated navigation systems (i.e., Doppler), a waypoint is usually inserted as a bearing and distance from a previous position.

6. GENERAL NAVIGATION PRACTICES AND PROCEDURES. Experience indicates that the increased accuracy and reliability of modern automatic navigation systems can induce a degree of complacency in the operator which may result in the failure to routinely cross check system performance. Under these circumstances, human errors may remain undetected for excessive periods. Although navigation errors are infrequent occurrences, human errors have accounted for a majority of the errors attributed to aircraft equipped with automated systems. Most inadvertent navigation errors have occurred when the equipment was functioning normally. The operating procedures prescribed were either inadequate or were not followed. A common error associated with automated systems is incorrect programing of the oceanic waypoint latitudes by multiples of one degree (60 nautical miles (nm)). In an organized track system, this can result in the flight maintaining a wrong track with high precision and thereby constituting a serious threat to other aircraft properly occupying that track and flight level. Vigilance and diligence in properly applying established procedures are essential ingredients of safe oceanic navigation. Although operational procedures (checklists) may differ slightly between specific navigation systems, many good practices and procedures are basic to all automated and semiautomated systems. These basic practices and procedures are presented in this paragraph.

a. Preflight Planning. One of the basic fundamentals of good navigation is prior planning. Aside from planning to ensure successful navigation under normal circumstances, the successful resolution of many in-flight navigation difficulties depends to a large degree on thorough preflight planning. Some of the more important factors are addressed below:

(1) The Navigation Flight Plan. Since many operators use a computerized navigation flight plan, this planning task has been greatly simplified. However, care should be taken to verify that all en route waypoints are correctly and legibly shown on the flight plan. Also, it is desirable to select a waypoint loading sequence and number each waypoint accordingly. If more than one copy of the flight plan is to be used by various crewmembers, designate one as the official copy. To eliminate possible confusion, ensure that all necessary information (i.e., routing changes, estimated times of arrival, waypoint loading sequence) is recorded on this flight plan and this copy is used for all reports to ATC. Additionally, if the flight is within the North Atlantic Organized Track Structure (OTS), obtain a copy of the current track message (ATC expects the flightcrew to have a copy) and be alert for a conflict between the flight plan and the track message. Track messages are issued periodically and describe the North Atlantic routes, gateways and flight levels available for eastbound and westbound flights during the period indicated in the message (usually 12 hours).

(iv) With systems such as INS or Omega, which navigate during ground operation, it is advisable to cross check present position, taxi distance or groundspeed, as appropriate, prior to takeoff to confirm proper system operation and to ensure that the present position remains reasonable.

b. En Route - Within Range of the Outbound Gateway. Flights should not continue beyond the outbound gateway unless the required long-range navigation equipment is functioning properly. To confirm proper operation, certain cross-checks should be performed while within range of the gateway navigation aid. Since this may be the last positive position cross-check until the inbound gateway, the following practices may also provide valuable information for resolving any later navigation difficulties:

(1) ATC Clearance. All ATC oceanic clearances should be cross checked by two crewmembers to ensure the clearance is copied correctly. Any flight plan waypoints which may have been revised in an ATC clearance should be crossed out and the revised coordinates entered in a legible manner. Prior to proceeding outbound from the gateway, the currently effective ATC clearance should be compared to the flight plan and the information in the navigation computers for the gateway and the subsequent waypoints should be verified.

(2) Gross Error Check. A gross error check is a position accuracy cross-check, using normal airway facilities such as VOR, VOR/DME or NDB. The gross error check is usually accomplished by flying directly over the gateway (if possible) and subsequently establishing the aircraft on the outbound course using the gateway navigation aid. This check serves the following purposes:

(i) Detects errors which may have accrued in position information since takeoff.

(ii) Provides information which can be used to determine which system is most accurate for use as a steering reference.

(iii) Provides an opportunity to correct position information, if necessary.

(iv) Can be used to confirm that the aircraft is established on the outbound course and is tracking toward the next waypoint.

(v) Can be used to confirm that the aircraft is proceeding via the currently effective ATC clearance.

(3) "Radio/Nav" Switches. In cases where flight instruments are used for the display of either airways (VOR) information or information from the long-range navigation system, the "Radio/Nav" switches should be left in

(2) Confirm that the aircraft is tracking along the next flight segment (tracking outbound).

(3) Approximately 10 minutes after passing each waypoint, the present position information on the navigation displays should be plotted on a navigation chart to confirm that the ATC clearance is satisfied (not applicable to most Doppler systems).

f. En Route - Approaching the Inbound Gateway. Certain preparations should be made for the transition from long-range navigation to airways navigation. The following practices are recommended:

(1) As soon as feasible, set up the navigation radios to receive the inbound gateway navigation aid.

(2) When the gateway navigation aid is providing reliable information, place the "Radio/Nav" switch in the "Radio" position and steer the aircraft so as to acquire and maintain the proper inbound radial/bearing.

(3) Unless directed otherwise by ATC, the aircraft should be flown directly overhead the gateway.

(4) When overhead the gateway, record the position information from the navigation displays. This information can be used to confirm system accuracy. It is recommended that system accuracy computations be made after arrival to avoid conflicts with other cockpit duties during the critical periods of descent, approach and landing.

g. After Arrival. The individual navigation system errors and error rates, if applicable, should be computed and recorded for future reference. It is desirable to record this information in a document which remains aboard the aircraft to provide subsequent flightcrews with a recent history of system performance. This information may be used with most systems to predict individual system performance for future flights under similar circumstances. Additionally, this information may prove valuable to subsequent flightcrews for resolving navigation abnormalities, such as a divergence between systems.

7. SPECIAL PRACTICES AND PROCEDURES - DOPPLER. In addition to the general practices and procedures contained in paragraph 6, the following information applies to Doppler navigation systems. Since a Doppler system (sensor plus computer) is a semi-automatic dead reckoning device which is less accurate than an INS or Omega system, a means of updating the Doppler is usually required if acceptable position accuracy is to be achieved on long-range flights. INS, Omega or LORAN C may be used as the updating reference for the Doppler system. The following factors should be considered when using Doppler navigation systems:

d. Updating the Doppler Computer.

(1) Since Doppler systems (in the magnetically slaved mode) fly a "rhumb line" (curved) track and most navigation charts commonly used reflect "great circle" (straight) tracks, certain precautions should be observed when updating Doppler systems. Although a great circle course and a rhumb line course begin and end at common points, a divergence between the two courses exists between the waypoints. This divergence normally reaches a maximum near the midpoint of the leg and the magnitude of the divergence increases as the latitude and the distance between waypoints increases.

(2) Under normal circumstances, position fixes for Doppler update purposes should be obtained within 75 nm of a waypoint to minimize the possibility of inducing an error into the Doppler system due to the "rhumb line" effect. This practice should be applied to both manually obtained and automatically obtained position fixes.

(3) When Doppler systems are used in the grid (free gyro) mode, the Doppler track will approximate a "great circle" and "rhumb line" effect is not a factor. Under these conditions, the updating restrictions previously detailed are not normally applicable.

8. SPECIAL PRACTICES AND PROCEDURES - INS. In addition to the general practices and procedures in paragraph 6, the following recommendations apply specifically to INS:

a. Preflight.

(1) Since INS is a dead reckoning device and not a position fixing device, any error induced during alignment will be retained and possibly incremented throughout the flight unless removed through updating procedures. Therefore, during preflight, care should be exercised to ensure that accurate present position information is "inserted" into the INS. Although most INS will automatically detect large errors in present position latitude during alignment, large errors in present position longitude may exist without activating a warning indication. Therefore, when cross checking present position coordinates, be alert for the correct hemispheric indicator (i.e., N, S, E, W) as well as the correct numerical values. Since most INS cannot be realigned in flight, special procedures, such as ground realignment, may be required to correct a significnt error in present position. If the INS in use have the capability of "gang-loading" (simultaneous loading) by use of a remote feature, care should be taken so that any data entered by this method is cross checked separately on each individual INS to detect data insertion errors.

(2) The INS software identification and modification status codes should be verified to ensure that the proper equipment is installed and the appropriate operating checklist is used.

c. Whereas INS position errors normally accrue gradually with elapsed flight time, most Omega errors occur suddenly and are usually multiples of the basic lane width. Effective cross checking procedures should be accomplished at regular intervals and LAR or inflight updating should be initiated when the position accuracy is in doubt. In addition to the general practices and procedures contained in paragraph 6, the following recommendations apply to Omega systems:

(1) Preflight.

(i) Be alert for any NOTAMS affecting the operational status of the individual Omega transmitters; particularly for possible abnormal operation. Deselection of any station reported to be in abnormal operation should be considered at the onset of the flight. Also be alert for any NOTAMS relating to propagation disturbances, such as Sudden Ionospheric Disturbances, Sudden Phase Anomalies, or Polar Cap Anomalies, which may affect Omega positioning accuracy. Scheduled Omega status broadcasts on station WWV should be monitored as a means of obtaining current Omega information.

(ii) The OMEGA software and modification status codes should be verified to ensure that the proper equipment is installed and that the appropriate operating checklist is used.

(iii) At certain ground locations, particularly at congested terminals, abnormally high radio noise levels may adversely affect the Omega. For example, synchronization may take longer than normal or the inserted ramp coordinates may drift after insertion. Synchronization or DR warning lights usually indicate this situation. This problem normally disappears, if the Omega equipment is serviceable, shortly after the switch to aircraft power or after the aircraft is moved from the gate. Care should be exercised during taxi, since abrupt turns may cause a momentary loss of signals which could affect system accuracy. It is good practice to cross check present position coordinates or taxi distance before takeoff to detect any errors which may have occurred since initialization.

(2) In-Flight Updating. The same considerations basic to updating an INS also apply to Omega due to the normal accuracy and reliability of these systems. However, in addition to the capability to update overhead a navigation aid, most Omega systems are capable of performing a LAR if certain signal strength and station geometry requirements are met. Unless an apparent Omega error exceeds approximately 6 nm, a lane slip may not necessarily have occurred and LAR or updating is not normally recommended. If an LAR appears to be necessary, the LAR should be initiated on only one system at a time so that the other system remains unaffected for use as a cross-check. The LAR should be attempted first on the system believed to be the least accurate.

10. NAVIGATION DIFFICULTIES. Although the accuracy and reliability of the newer automated navigation systems are excellent, malfunctions and failures occasionally occur. When a malfunction occurs, crews should guard against jumping to conclusions since hasty actions are seldom necessary and may

(6) Cross-check heading, groundspeed, track and wind information between systems and compare to best known information.

(7) Attempt to contact nearby aircraft to obtain wind or groundspeed and drift information which may identify the malfunctioning system.

(8) The compass deviation check discussed in paragraph 6b(4) may provide a clue as to which system is faulty for systems such as INS.

NOTE: Even though these steps are taken, the occasion may still arise where a divergence between systems is observed, but the crew cannot determine which system is at fault. When this occurs, the practices in paragraph 10d should be used.

c. Recommended Actions Following System Failure. After a system malfunction or failure has been detected, ATC should be informed that the flight is experiencing navigation difficulties so that separation criteria can be adjusted, if necessary. Reporting malfunctions to ATC is an ICAO requirement and compliance is required by FAR Part 91. If the failed system can be identified with a high degree of confidence and the other system appears normal, the best course of action may be to fly the normal system and carefully monitor its performance using any additional navigation aids available, including DR. In the unlikely event that a total navigation failure occurs and other aids are unavailable, the only action may be to dead reckon using the flight plan headings and times. Under these circumstances, continue to use all means available to obtain and use as much navigational information as possible. Be alert for visual sightings of other aircraft since a potential hazard may exist due to inadverent deviation from your assigned track. Also, in some cases, it may be possible to establish and maintain visual contact with another aircraft on the same track.

d. Recommended Actions Following a Divergence Between Systems. Since a small divergence between systems may be normal, the significance of the divergence should be evaluated. In general terms, if the divergence is less than 10 nm, the best course of action may be to closely monitor system performance and continue to steer the system considered most accurate. If the divergence between systems is greater than 10 nm, one of the systems may be degraded. Therefore, attempts should be made to determine which system may be faulty. If the faulty system cannot be determined using the practices in paragraph 10b and both systems appear normal, the action most likely to limit gross tracking errors may be to position the aircraft so that the actual track is midway between the crosstrack differences for as long as the position uncertainty exists. ATC should be advised that navigation difficulties are being experienced so that separation criteria

APPENDIX 1. RELATED READING MATERIAL

Additional information concerning navigation practices, procedures and equipment may be found in the following documents:

1. Federal Aviation Administration (FAA) Advisory Circulars.

   a. Advisory Circular 90-76, Flight Operations in Oceanic Airspace.

   b. Advisory Circular 91-49, General Aviation Procedures for Flight in North Atlantic Minimum Navigation Performance Specifications Airspace.

   c. Advisory Circular 120-31A, Operational and Airworthiness Approval of Airborne Omega Radio Navigation Systems as a Means of Updating Self-Contained Navigation Systems.

   d. Advisory Circular 120-33, Operational Approval of Airborne Long-Range Navigation Systems for Flight Within the North Atlantic Minimum Navigation Performance Specifications Airspace.

   e. Advisory Circular 120-37, Operational and Airworthiness Approval of Airborne Omega Radio Navigation Systems as a Sole Means of Overwater Long Range Navigation.

   f. Advisory Circular 121-13, Self-Contained Navigation Systems (Long Range).

Copies of these documents may be obtained free of charge from the U.S. Department of Transportation, Publications Section M 443.1, Washington, D.C. 20590.

2. Other Federal Aviation Administration Documents.

   a. Airman's Information Manual, Basic Flight Information and ATC Procedures.

   b. International Flight Information Manual.

   c. International Notices to Airmen.

Copies of these documents may be obtained on a subscription basis from the Superintendent of Documents, U.S. Government Printing Office, Washington, D.C. 20402.

3. International Civil Aviation Organization (ICAO) Documents.

   a. Annex 2 to the Convention on International Civil Aviation -- Rules of the Air.